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From the Editors:

The COVID-19 Crisis and its Implications for Pediatric Surgeons

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“.....and there are no more surgeons, urologists, orthopedists...we are only doctors who suddenly become part of a single team to face this tsunami that has overwhelmed us...”.

Dr. Daniele Macchine, Bergamo, Italy, March 9th, 2020

Introduction

Currently we have a spectre stalking each and every land through which it passes. It has been sudden in onset, ceaseless and remorseless, and overwhelming all attempts at control and containment. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the virus causing coronavirus disease 2019 (COVID-19), the respiratory illness. Its epicentre seems to have been within the Huanan Seafood Wholesale Market in the city of Wuhan, Hubei province, China's 11th largest city with about 10 million inhabitants. This market is a source not only of seafood, but of many, many species of exotic wild animals brought alive and often slaughtered within its confines. The virus itself is probably zoonotic with a reservoir maybe in bats and maybe an intermediate host in pangolins (aka “spiny anteaters”), which are particularly popular

in this market as its meat is considered a delicacy and its scales a source of some constituents of traditional Chinese medicines.

Cases started to appear in early December 2019, particularly in market traders and stall holders, and then in the health workers looking after them. By December 31st, some 27 patients had been identified as having a “pneumonia of unknown origin”. At that point the viral genome had been partly sequenced and recognised as novel, and the Chinese authorities notified the World Health Organization (WHO) of their suspicions. Hong Kong, Macau and Taiwan started screening and restricting travelers from Wuhan from this date. The market was shut down on January 1st 2020.

The international scientific response was rapid, with posting of the genome on the NIH-supported database GenBank on January 13th, development of a rapid diagnostic test by researchers from the German Center for Infection Research (DZIF) at Charité – Universitätsmedizin Berlin on January 16th, and the first published clinical series in the Lancet on January 24th (1). The first fatality was confirmed on January 11th, with only a handful of confirmed deaths in Wuhan thereafter. But the genie had been let out of the bottle and it wasn't getting back in again any time soon. Dr. Tedros Adhanom Ghebreyesus, Director-General of the WHO, declared the outbreak a pandemic on March 11th, 71 days after the market in Wuhan was closed.

Perhaps mercifully, the brunt of the viral onslaught has not been borne by children or adolescents, though they are no more immune than the rest of the community. Rather, it is the elderly and those with other co-morbidities such as diabetes, hypertension, etc. who have been most at risk. Latest Italian estimates for those >80 years suggest a case fatality rate (CFR) of 20% with only tragically exceptional deaths in those <20 years. There are, of course, vulnerable groups among the young such as those with chronic respiratory impairment due to prematurity, cystic fibrosis, severe asthma; the immunocompromised post-transplant patient; those undergoing treatment for malignancy; those taking long-term (>1 month) steroids; and those with asplenia (surgical or congenital), cyanotic congenital heart disease, and chronic kidney disease (stage 4,5 or on dialysis).

In many countries where COVID-19 has caught hold, everything and everyone have been on “lock-down”, typically with confinement to home, restrictions on non-essential work, and limited opportunities for exercise. The paediatric emergency areas are empty (no one wants to

go to the hospital unless they really need to). This complete shut-down of hospital-based services for elective surgery and child health may have unintended consequences further down the line on the health of the younger generation. How much pathology will be missed in the absence of clinical examination remains unknown.

Experience in China and the Rest of Asia

Within the space of a few months, COVID-19 has escalated from a little known respiratory infectious disease concentrated in a hotspot in China to a devastating pandemic threatening the health and disrupting the daily life of everyone around the world. In parts of Asia, there is a sense of *déjà vu*. The Severe Acute Respiratory Syndrome (SARS) arrived out of the blue in 2003 as a highly lethal epidemic, devastating several communities. Pediatric surgery might have been a footnote during SARS, but was hardly a bystander: in Hong Kong, a pediatric surgeon-scientist characterized genetic susceptibility to SARS in a high-impact study (2). In contrast, sadly, a pediatric surgeon (Dr. James TK Lau) contracted SARS during work and died. While SARS did not develop into a pandemic, lessons learned stayed with the affected populations. As the first cluster of patients from Wuhan was being reported to the WHO on December 31st pediatric surgeons (including several editorial board members in their professional capacities) were gathering in Wuhan on January 3rd for a symposium on Hirschsprung Disease and a conference on robotic surgery, oblivious to what would lie ahead. Those of us scarred by the bitter experience of SARS 17 years earlier were nervous and took extra precautions. But the public alarm of the serious health threat did not start until the identification of the novel coronavirus as the cause of the disease on January 7th, and the observation of the exponential increase in the number of cases in Wuhan and neighbouring regions, soon spreading to other parts of China, Asia (Thailand reported the first case on January 13th) and the rest of the world (the U.S. reported the first case on January 20th). During the first month, while few cases were encountered outside of the country, the disease threatened to spiral out of control within China. Drastic measures were implemented, starting with Wuhan being locked down on January 23th, followed by the entire Hubei Province and other parts of China. On January 30th, in recognition of the global threat, the WHO declared a global public health emergency. Unlike SARS, which shattered several parts of Asia but disappeared after three

months, the new COVID-19 proved to be much more contagious, with the number of confirmed cases skyrocketing worldwide. While the extreme quarantine measures in China seems to have brought the spread of disease under control at this time (early April), other countries are facing the full forces of this “infectious hurricane”.

The experiences in China, Hong Kong, Japan and other parts of Asia suggest that children are less frequently and less severely affected by COVID-19 than adults, and surgical patients constitute a small proportion of COVID-19 pediatric patients. However, they are not exempt from the infection. A series of 6 children with COVID-19 from Wuhan was first reported in early January, although no surgical patients were involved (3). The first pediatric surgical mortality was recorded in February (a 10-month old child with intussusception who died from multi-organ failure after a 4-week hospitalization) (4). On a somber note that mirrored events during SARS in Hong Kong, the Philippines mourned the loss of a senior surgeon (Dr. Leandro I Resurreccion III) in the battle against COVID-19. These anecdotes illustrate that in the ongoing war against COVID-19, while pediatric surgery remains a small player in the “big picture”, we cannot afford to ignore any pediatric surgery-specific issues. It is important for pediatric surgeons in the early phase of COVID-19 era to publish their experiences, however limited, to assist surgeons in communities likely to be hit by COVID-19 later. Good science, sound clinical judgement, and data were primarily responsible for the successful fight against SARS in Asia. In the war against COVID-19, basic, translational and clinical research is likely to play a key role again.

We know from the SARS experiences, and now from the COVID-19 pandemic, that the most effective preventive measures revolve around population-wide testing for the virus, contact tracing, quarantine/isolation, social distancing, travel restrictions, hand hygiene, and mask-wearing (an already widely accepted behavior in SARS-affected communities). Disease treatment is mostly supportive at this time, but efforts are being made towards the identification of drugs that could hasten recovery and reduce mortality (e.g. hydrochloroquine). Mass vaccination is widely acknowledged to be the ultimate solution, but while early human trials have started, it is likely that it will be many months before a safe and effective vaccine will be ready. While universal preventive WHO guidelines are the cornerstone against COVID-19, each community has to develop its own handbook of instructions adapted to local practices and needs, updated regularly, and communicated to staff effectively. Guidelines from pediatricians in China

were promulgated early during the crisis (5,6). In Hong Kong, a weekly/biweekly interactive staff forum (with teleconferencing access) was conducted by the hospital leadership and relevant experts as the crisis escalated. Protecting health care workers is a top priority as any health care system will collapse if a large number of practitioners become patients.

Experience in the European Union and the UK

France reported three confirmed cases on January 24th, the first occurrences within the European Union with connection to China. On February 14th, an 80-year-old Chinese tourist died in Bichat–Claude Bernard Hospital, Paris. That was Europe's first fatality. Isolated cases, typically in tourists or repatriated nationals, swiftly followed throughout the rest of February, but towards the end of March, a full-blown outbreak had been confirmed in and around Milan in Lombardy, Northern Italy (7). Cases and deaths increased across the continent exponentially with major outbreaks being found in Spain and France.

Interestingly, the effects of the disease appear to be varied across Europe with some countries' health systems being overwhelmed with high numbers of deaths (e.g. Italy and Spain) and others where the overall numbers have appeared high but deaths proportionately small (e.g. Germany) (8). This can be numerated by considering the CFR for COVID-19 which, based on the early Chinese data, has been calculated to be around 4%. On that basis, Germany is at this time much lower at about 2% compared to around 10-12% for Italy and Spain, both of whom top the current European mortality statistics (9) (Table 1).

Since person-to-person spread appears to be largely by aerosolized droplet transmission and surface contact from sufferers during their symptom peak, surgeons and anaesthesiologists are at particular risk given their intimate contact with patients on the ward and in the operating room. Personal protective equipment (PPE) for all staff is mandatory but shortages and access have been reported widely. FFP-2 (Filtering Face-Piece) (the equivalent to the N95) masks made of a conforming synthetic polymer weave have been approved by WHO though FFP-3 masks (typically with an expiration valve) appear more protective and are the standard in the UK.

Experience in Finland and the Other Nordic Countries

The number of symptomatic COVID-19 patients and virus-related deaths in the Nordic countries are still much less when compared to most parts of the world and Europe. This might simply reflect the natural timespan for geographical spreading of the virus, and most likely, the situation will level at least to some degree in the near future. At this time, none of the infected children in Finland has required hospitalization, and no child has died in the Nordic countries. However, the national approach to the pandemic threat has been very different in individual Nordic countries, which may also affect how much and for how long the pandemic will disturb pediatric surgery. For example, Sweden has adopted a relatively liberal approach without really restricting free-time activities or movement of people. Finland, by contrast, issued prompt actions very early in the course of the epidemic to try to constrain and slow down COVID-19 spread, with the hope of thus increasing the number of intensive care beds. These restrictions have included temporary lock-down of the Helsinki-Uusimaa region with 1.7 million inhabitants (representing 30% of the population and with the largest children's hospital and national pediatric surgery referral center in the country), cessation of schools and universities, closure of restaurants, and prohibition of all public events.

Most pediatric surgical patients thus far are suffering mostly from “collateral damage” since the national health care system is being primed to manage the increasing number of severely affected adult patients. Already, a number of anesthesiologists and nurses in the Helsinki Children's Hospital have been relocated to adult intensive care units or have training for providing critical adult care, reducing pediatric surgical resources. Elective and day surgery have been reduced, although emergent and most semi-emergent operations, including most organ transplantation, are performed according to usual practice.

Although movement of pediatric patients is not officially restricted from other parts of Finland to Helsinki, many parents, also local ones, are postponing their child's operation for fear of infection, contributing to the significantly decreased activity in pediatric surgery. In some patients, this unplanned delay may have a significant negative effect on surgical outcomes, but the consequences of the infection are potentially much more significant for the parents than their child. Most strikingly, the number of emergency department visits has crashed, and the true

consequences remain yet to be seen, as some of these patients have underlying conditions requiring urgent intervention. Limited supply of ECMO equipment due to the wide-spread infection situation in the concentrated production areas of the Europe, the Nordic countries, and the world has obligated prioritization of care to those patients with the greatest need.

Experience in Latin America

South American countries witnessed the early development and rapid expansion of the disease from a distance. Some countries, such as Argentina, Bolivia, Uruguay and Chile, were aggressive in implementing measures to limit the influx of COVID-19 early in the pandemic. The generalized closing of national borders, harbors and airports, the mandatory commercial lock-down, and the social distance rules have resulted in a remarkable low number of deaths in these countries. As of April 14th, the total death count is slightly above 215 in these countries. Other countries in the region, such as Brazil and Ecuador, were either late to implement measures or were less successful in enforcing them and are therefore seeing much worse numbers. Fortunately, and mirroring what has occurred in other regions of the world, the number of pediatric cases has been minimal so far. For instance, at the National Pediatric Hospital in Buenos Aires (the largest pediatric hospital in Argentina), there have been no COVID-19 cases yet. However, the entire region is bracing for the upcoming weeks, since the peak is expected to occur 3-4 weeks after the peak in Europe and 2-3 weeks after the peak in North America.

In the Central America region, the approach to the pandemic has been quite variable. Mexico, for example, did not implement measures to limit social activities until late March. COVID-19 cases have been increasing exponentially, and the number of deaths has tripled in the last week (about 90 on April 6th to about 270 on April 11th). The health system is vastly overwhelmed in some regions, and some cities (e.g. Tijuana) have started closing its hospital's doors. While the exact demographics of the COVID-19 patients are not known, there have been at least 3 COVID-19 cases in children younger than 1 year. In Colombia, on the other hand, the lock-down started in early March. As of today, the number of fatalities has been relatively low (about 100), but there have been at least 9 children who have tested positive, one of which required hospital admission.

Experience in North America

The incidence of pediatric COVID-19 cases requiring hospitalization in the U.S. has been low this far, but the peak is approaching. Children's hospitals across the U.S. are preparing twofold: on one side, to receive the potential surge of cases in the upcoming weeks, and on the other side, to provide the best possible protection to their workforce. Most children's hospitals across the U.S. have postponed all elective operations at this time. The only operations allowed are those that can speed up the hospital discharge of patients already admitted, and obviously all emergencies. Most U.S. children's hospitals now require all patients to be tested for COVID-19 prior to going to the operating room. Rapid RT-PCR tests with a turnaround time of less than 2 hours from nasopharyngeal swabs have already been developed, but are not available everywhere, and still have an unknown false negative rate. In the event of a life-threatening or limb/organ-threatening situation, patients are assumed COVID-19 positive and, at many hospitals, are treated in a dedicated negative-pressure operating room, with appropriate PPE. All Level-I and Level-II trauma resuscitations are treated as COVID-19 positive or at least as "person under investigation" (PUI), with only essential personnel inside the trauma bay. For all operations, non-essential team members must remain outside of the operating room at the time of anesthesia induction and airway intubation. Many pediatric surgery groups across the U.S. have divided and the teams are staggered in order to have a team on service and a team on back up, or even just a weekend-like crew on-site every day. One reason for separating the surgical group into different teams is to make sure the entire team of surgeons does not contract the disease at the same time. Some pediatric surgery groups have excluded from clinical duties surgeons older than 60 years of age or those who are vulnerable in any other way. Several pediatric surgery groups are seeing their rotating residents being pulled back to their own general surgery programs, and even though the overall surgical volumes have dropped remarkably, this move decreases the number of bodies available for on-service/off-service schedules. In some hospitals, residents and fellows are kept off all clinical duties related to COVID-19 positive patients, leaving that role for the attending surgeons. Several children's hospitals have even modified their scope of practice to adapt to the crisis. Some have opened units for the care of adult patients (COVID-19 positive or negative), and most have extended the age of the patients that can be

admitted to pediatric units to 25 years. Lastly, some pediatric surgeons around the country are taking shifts in adult COVID-19 intensive care units, or in adult trauma services.

Pediatric surgical care practices have been modified in some hospitals, but not in all. In the case of acute appendicitis, some institutions have adopted non-operative treatment when appropriate, whereas other places continue to operate on all cases. The reason for the latter is that most patients with simple appendicitis can be discharged home from the post-anesthesia care unit shortly after the operation, whereas patients treated non-operatively require at least 24 hours in the hospital for intravenous antibiotics, which represents a longer time for patients and their family members being potentially exposed to COVID-19, and an unnecessary use of hospital beds and personnel. There is no right or wrong management choice, and each institution is adopting the strategy believed to be the most appropriate according to their manpower, hospital resources, and limitations. In the particular case of ECMO cannulations, some institutions have determined that patients with baseline diseases who develop COVID-19-related ARDS will not be candidates for ECMO/ECPR. However, since the need for ECMO in COVID-19 positive children/teenagers has been minimal so far (not zero), the eligibility is being evaluated on a case-by-case basis. As regards the use of laparoscopy and thoracoscopy, there is growing concern world-wide related to the potential aerosolization of viral particles through the pressurized CO₂. Evidence is lacking, but many institutions are turning towards open procedures (for example for pyloromyotomies) and are implementing the use of filters for insufflation/desufflation, and the use of smoke evacuators throughout the entire operation. These devices, however, are not available everywhere.

At the time of this writing, almost every major children's hospital across the U.S. has had COVID-19 patients. However, the minority have presented to the hospital with respiratory symptoms, only a few required a transfer to the intensive care unit, and only one (to our knowledge) has required ECMO. Most of the COVID-19 pediatric surgical patients have actually presented to the hospital with a variety of surgical needs, and then were found to be COVID-19 positive on the preoperative screening or testing of patients who have had close contacts with confirmed cases. Lastly, as of April 14, there have been 2 neonatal deaths, and at least one more newborn requiring admission, all infected through vertical transmission.

Pediatric surgeons and children's hospitals in the U.S. are adapting to this pandemic in ways never seen before. Each institution, as well as each national surgical society, is setting

guidelines for optimal patient care and for the protection of healthcare workers. Some of these guidelines are based on evidence, whereas some are only based on hope. As the crisis approaches its predicted peak in the U.S. in the upcoming days/weeks, pediatric surgeons must remain in close (virtual) contact with each other and take advantage of the experiences of our colleagues around the world.

Effects on Pediatric Surgery Trainees

There are no areas of healthcare that have not been impacted by the COVID-19 pandemic, and the education of our pediatric surgery trainees is no exception. Since the beginning of the crisis, training programs (at least in the U.S.) have been forced to adjust the workflow of their trainees in order to minimize exposure to COVID-19, not just for the sake of their health (a blunt truth), but to have a backup person if one falls ill. In many programs one fellow remains on home lock-down each week. In some programs the pediatric surgery fellows are being pulled into the medical care of adult patients, as is also happening to many general surgery residents across the U.S. who are being pulled to work as medical interns, or even to fill nursing roles. Most elective pediatric surgery cases, appropriately, were cancelled for a minimum of 6 weeks starting in mid-March. This time frame will likely be extended, since the peak of COVID-19 cases in the U.S is anticipated to occur in mid- to late April. Weekly teaching conferences are reduced to a minimum, and the few that occur are by videoconference. Clinic visits are almost all video visits with no participation of trainees, in order to limit their interaction with co-workers in non-essential activities. Morning and afternoon patient rounds are limited to the essential personnel, with didactic discussions reduced to near zero. Surgical units have been shut down to reduce traffic of personnel, which brought the number of inpatients with typical pediatric surgical conditions to almost zero (except for patients treated for emergencies). Pediatric surgery fellowships in the U.S. are only two years long, and within those two years the trainees take several weeks off for vacation, holidays, surgical meetings, and job interviews. With all the changes described above, it is easy to see that if the COVID-19 crisis extends even a mere two to three months, it will cause a significant negative impact to the overall surgical experience of our trainees. When the psychological toll that this pandemic is putting on our trainees is added to the natural fear for the well-being of their loved ones with whom they live

(as all healthcare workers who are exposed daily to COVID-19 do), suddenly “training” does not feel as a priority anymore.

There are strict requirements established by the regulatory bodies (e.g. American Board of Surgery) that trainees must fulfill in order to graduate. One of them is the number of operations that surgical trainees need to perform before the end of their training. These required numbers have already been lowered (as have the required number of weeks of clinical time) because it is very likely that trainees in many programs won't be able to fulfill them. These administrative changes, however, are simple technicalities. The real challenge will be for all pediatric surgery training programs to find effective ways to fill the educational gap that this unpredicted crisis is causing. This may come in the form of extended training times, relaxed working hour restrictions, reduced administrative obligations, individualized mentorships, and collaborations between training programs, among others. We, as a community of pediatric surgical educators, owe our pediatric surgery trainees every bit of the training that we promised them.

Conclusions

Pediatric surgery around the world has been profoundly impacted by the COVID-19 pandemic. From the ways in which we practice, to the ways in which we teach and learn, to what we can and cannot do for our patients, every aspect of our profession has been changed on an unprecedented scale. These are challenging times, for us and for our patients. We must multiply our efforts to share each other's learned lessons and to maintain the highest standards as we navigate this unforeseen storm. The Journal of Pediatric Surgery is committed to provide a valuable platform to disseminate relevant new knowledge, and to contribute meaningfully to the health and well-being of all children and their families around the world.

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TABLE 1: Confirmed Cases and Deaths due to COVID-19 (April 14th 2020)

	No. confirmed cases	Deaths	Crude Case Fatality rate
Europe			
Spain	170,099	17,756	10.4%
Italy	159,516	20,465	12.8%
France	137,877	14,967	10.8%
Germany	130,072	3,194	2.4%
UK	89,571	11,329	12.6%
Belgium	30,589	3,903	12.7%
Netherlands	26,712	2,823	10.5%
Finland	3,064	59	1.9%
North America			
USA	587,337	23,649	4.0%
<i>New York (State)</i>	195,031	10,056	5.1%
Canada	25,680	780	3.0%
South America			
Brazil	23,723	1355	5.7%
Argentina	2,277	98	4.3%
Asia			
China	83,303	3341	4.0%
<i>Hubei (Wuhan)</i>	67,803	3221	4.7%
South Korea	10,564	222	2.0%
Japan	7,645	143	1.8%
Hong Kong	1,010	4	0.39%

Data based on Johns Hopkins University Dashboard

<https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6>